10/070738 MAR 2002

FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

# TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER
**APV31549**

U.S. APPLICATION NO (IF KNOWN, SEE 37 CFR
10/070738

| INTERNATIONAL APPLICATION NO | INTERNATIONAL FILING DATE | PRIORITY DATE CLAIMED |
|---|---|---|
| PCT/EP00/03505 | April 13, 2000 | April 20, 1999 |

TITLE OF INVENTION
**COOLING PANEL FOR A SHAFT FURNACE, SHAFT FURNACE PROVIDED WITH COOLING PANELS OF THIS NATURE, AND A PROCESS FOR PRODUCING SUCH A COOLING PANEL**

APPLICANT(S) FOR DO/EO/US
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**Alex LAJTONYI** **Johan Egenolf VAN STEIN CALLENFELS**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C 371
3. ☐ This is an express request to begin national examination procedures (35 U.S.C 371(f)) The submission must include itens (5), (6), (9) and (24) indicated below
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31)
5. ☒ A copy of the International Application as filed (35 U S C 371 (c) (2))
   a ☒ is attached hereto (required only if not communicated by the International Bureau)
   b. ☒ has been communicated by the International Bureau
   c ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☐ An English language translation of the International Application as filed (35 U S C 371(c)(2)).
   a. ☐ is attached hereto.
   b ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U S C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau)
   b ☐ have been communicated by the International Bureau
   c ☐ have not been made; however, the time limit for making such amendments has NOT expired
   d. ☐ have not been made and will not be made
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S C 371(c)(3))
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C 371 (c)(4))
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U S C 371 (c)(5))
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409)
12. ☒ A copy of the International Search Report (PCT/ISA/210)

**Items 13 to 20 below concern document(s) or information included:**

13. ☒ An Information Disclosure Statement under 37 CFR 1 97 and 1 98.
14. ☐ An assignment document for recording A separate cover sheet in compliance with 37 CFR 3 28 and 3 31 is included
15. ☒ A **FIRST** preliminary amendment
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment
17. ☐ A substitute specification
18. ☐ A change of power of attorney and/or address letter
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter 2 and 35 U S C 1 821 - 1 825
20. ☐ A second copy of the published international application under 35 U S C 154(d)(4)
21. ☐ A second copy of the English language translation of the international application under 35 U S C 154(d)(4)
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information

   **Cover Sheet of International Application as Published**
   **Notice of Claim for Priority**
   **Petition to Revive For Unintentional Abandonment Under 37 CFR 1.137(b)**

JC10 Rec'd PCT/PTO 12 MAR 2002

| U.S. APPLICATION NO (IF KNOWN, SEE 37 CFR | INTERNATIONAL APPLICATION NO | ATTORNEY'S DOCKET NUMBER |
|---|---|---|
| 10/070738 | PCT/EP00/03505 | APV31549 |

24. The following fees are submitted

| | | CALCULATIONS | PTO USE ONLY |
|---|---|---|---|
| **BASIC NATIONAL FEE ( 37 CFR 1.492 (a) (1) - (5)) :** | | | |
| ☐ Neither international preliminary examination fee (37 CFR 1 482) nor international search fee (37 CFR 1 445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO | $1040.00 | | |
| ☒ International preliminary examination fee (37 CFR 1 482) not paid to USPTO but International Search Report prepared by the EPO or JPO | $890.00 | | |
| ☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1 445(a)(2)) paid to USPTO | $740.00 | | |
| ☐ International preliminary examination fee (37 CFR 1 482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) | $710.00 | | |
| ☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) | $100.00 | | |
| **ENTER APPROPRIATE BASIC FEE AMOUNT =** | | $890.00 | |
| Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1 492 (e)) | | $0.00 | |

| CLAIMS | NUMBER FILED | NUMBER EXTRA | RATE | | |
|---|---|---|---|---|---|
| Total claims | 16 - 20 = | 0 | x $18 00 | $0.00 | |
| Independent claims | 1 - 3 = | 0 | x $84 00 | $0.00 | |
| Multiple Dependent Claims **(check if applicable)** | | | ☐ | $0.00 | |
| **TOTAL OF ABOVE CALCULATIONS =** | | | | $890.00 | |
| ☐ Applicant claims small entity status See 37 CFR 1 27) The fees indicated above are reduced by 1/2 | | | | $0.00 | |
| **SUBTOTAL =** | | | | $890.00 | |
| Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1 492 (f)) + | | | | $0.00 | |
| **TOTAL NATIONAL FEE =** | | | | $890.00 | |
| Fee for recording the enclosed assignment (37 CFR 1 21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3 28, 3 31) **(check if applicable).** ☐ | | | | $0.00 | |
| **TOTAL FEES ENCLOSED =** | | | | $890.00 | |
| | | | | **Amount to be: refunded** | $ |
| | | | | **charged** | $ |

a. ☒ A check in the amount of **$2,170.00** to cover the above fees is enclosed

b. ☐ Please charge my Deposit Account No ______ in the amount of ______ to cover the above fees A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No **19-4375** A duplicate copy of this sheet is enclosed

d. ☐ Fees are to be charged to a credit card **WARNING:** Information on this form may become public **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038

**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.**

SEND ALL CORRESPONDENCE TO

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SIGNATURE

Anthony P. Venturino
NAME

31,674
REGISTRATION NUMBER

March 12, 2002
DATE

10/070738

JC10 Rec'd PCT/PTO 12 MAR 2002

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re the Application

Albert John DZERMEJKO et al

Serial No.: To be assigned (National Phase of PCT/EP00/03505)

Filed: March 12, 2002

For: COOLING PANEL FOR A SHAFT FURNACE, SHAFT FURNACE PROVIDED WITH COOLING PANELS OF THIS NATURE, AND A PROCESS FOR PRODUCING SUCH A COOLING PANEL

**PRELIMINARY AMENDMENT**

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

IN THE ABSTRACT

After the last page of claims, insert on a new page the Abstract shown on the attached sheet (ATTACHMENT I).

IN THE CLAIMS

Please amend the claims as follows. A copy of the claims marked up to show the amendments is attached (ATTACHMENT II).

1. Cooling panel for a shaft furnace, comprising at least one vertical duct which runs through the cooling panel, the ends of the at least one duct are connected to connection ends running transversely with respect to the plane of the cooling panel, wherein each duct and the connection ends are formed from a continuous tube made from a material selected from the group consisting of low-carbon steel, stainless steel and an alloy which predominantly comprises Cu and Ni with an Ni content of $\geq$ 28% by weight, and the remainder of the cooling panel

consists of copper which is cast around this tube, the cooling panel being provided, on a side remote from the connection ends, with a multiplicity of horizontal ribs.

2. (Amended) Cooling panel according to Claim 1, wherein the material of the continuous tube contains between 65 and 70% by weight Ni, approx. 3% Fe and $\leq$ 1% of one or more of the elements Mn, Si and C.

3. (Amended) Cooling panel according to Claim 2, wherein the material of the continuous tube consists of Monel, with a composition of approx. 28% Cu, 68% Ni, 3% Fe, 1% Mn and low Si and/or C contents.

4. (Amended) Cooling panel according to Claim 1, wherein the ribs have a length, in the width direction of the cooling panel, which is smaller than the width of the cooling panel.

5. (Amended) Cooling panel according to Claim 4, wherein the ribs have a length in the width direction of the cooling panel of $\leq$ 50% of the width of the panel.

6. (Amended) Cooling panel according to Claim 1, wherein the ribs are provided with supporting backs.

7. (Amended) Cooling panel according to Claim 6, wherein each of the ribs with a supporting back is T-shaped in cross section, parallel to the plane of the cooling panel.

8. (Amended) Cooling panel according to Claim 6, wherein each of the ribs with supporting backs are in the shape of a + in cross section, parallel to the plane of the cooling panel.

9. (Amended) Cooling panel according to Claim 6, wherein the ribs are provided with supporting backs on either side in the vicinity of their ends.

10. (Amended) Cooling panel according to Claim 1, wherein the wall is provided, on the side of the connection ends, on either side of each duct, with undulating recesses in which reinforcing walls which fill up these recesses are distributed over the height of the cooling panel.

11. (Amended) Cooling panel according to Claim 1, wherein the wall, on the side remote from the connection ends, is provided, on either side of each duct, with undulating recesses.

12. (Amended) Cooling panel according to Claim 1, wherein the ribs thicken towards their free ends remote from the main body of the cooling panel.

13. (Amended) Shaft furnace provided with a jacket which on the inside is at least partially provided with cooling panels according Claim 1.

14. (Amended) Process for producing a cooling panel according to Claim 2, wherein the continuous tube (or tubes) is firstly given its final shape, after which the copper for the cooling-panel body to be formed is cast as cast material around the tube at a temperature which is so close to the melting point of material of the tube that, after the cast material has cooled, the cast material is attached to the material of the tube.

Please add the following new claims.

--15. Cooling panel according to Claim 2, wherein the material of the continuous tube consists of Monel.

16. Cooling panel according to Claim 4, wherein the ribs have a length in the width direction of the cooling panel of $\leq$ 25% of the width of the panel.--

## REMARKS

The claims have been amended to delete the multiple dependent claim status and improve readability. No new matter is presented by the above amendments. Claim 15 is supported as is Claim 3. Claim 16 is supported as is Claim 5.

Early and favorable consideration of this application is respectfully requested.

Respectfully submitted,

Date: March 12, 2002 By: Anthony P. Venturino

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ATTACHMENT I


ABSTRACT

Cooling panel for a shaft furnace of the type through which at least one vertical duct runs, the ends of which are connected to connection ends running transversely with respect to the plane of the cooling panel, in which furthermore each duct and the connection ends are formed from a continuous tube made from a material selected from the group consisting of low-carbon steel, stainless steel and an alloy which predominantly includes Cu and Ni with an Ni content of $\geq$ 28 % by weight, and the remainder of the cooling panel consists of copper which is cast around this tube, the cooling panel being provided, on the side remote from the connection ends, with a multiplicity of horizontal ribs.

ATTACHMENT II - Marked Up Set of Claims

1. Cooling panel for a shaft furnace [of the type through which], comprising at least one vertical duct which runs through the cooling panel, the ends of [which] the at least one duct are connected to connection ends running transversely with respect to the plane of the cooling panel, [in which furthermore] wherein each duct and the connection ends are formed from a continuous tube made from a material selected from the group consisting of low-carbon steel, stainless steel and an alloy which predominantly comprises Cu and Ni with an Ni content of $\geq$ 28% by weight, and the remainder of the cooling panel consists of copper which is cast around this tube, the cooling panel being provided, on [the] a side remote from the connection ends, with a multiplicity of horizontal ribs.

2. (Amended) Cooling panel according to Claim 1, [characterized in that] wherein the material of the continuous tube contains between 65 and 70% by weight Ni, approx. 3% Fe and $\leq$ 1% of one or more of the elements Mn, Si and C.

3. (Amended) Cooling panel according to Claim 2, [characterized in that] wherein the material of the continuous tube consists of Monel, with a composition of approx. 28% Cu, 68% Ni, 3% Fe, 1% Mn and low Si and/or C contents.

4. (Amended) Cooling panel according to [one of Claims 1-3] Claim 1, [characterized in that] wherein the ribs have a length, in the width direction of the cooling panel, which is smaller than the width of the cooling panel.

5. (Amended) Cooling panel according to Claim 4, [characterized in that] wherein the ribs have a length in the width direction of the cooling panel of $\leq$ 50%[, preferably $\leq$ 25%,] of the width of the panel.

6. (Amended) Cooling panel according to [one of Claims 1-5] Claim 1, [characterized in that] wherein the ribs are provided with supporting backs.

7. (Amended) Cooling panel according to Claim 6, [characterized in that] wherein each of the ribs with a supporting back is T-shaped in cross section, parallel to the plane of the cooling panel.

8. (Amended) Cooling panel according to Claim 6, [characterized in that] wherein each of the ribs with supporting backs are in the shape of a + in cross section, parallel to the plane of the cooling panel.

9. (Amended) Cooling panel according to Claim 6, [characterized in that] wherein the ribs are provided with supporting backs on either side in the vicinity of their ends.

10. (Amended) Cooling panel according to [one of Claims 1-9] Claim 1, [characterized in that] wherein the wall is provided, on the side of the connection ends, on either side of each duct, with undulating recesses in which reinforcing walls which fill up these recesses are distributed over the height of the cooling panel.

11. (Amended) Cooling panel according to [one of Claims 1-10] Claim 1, [characterized in that] wherein the wall, on the side remote from the connection ends, is provided, on either side of each duct, with undulating recesses.

12. (Amended) Cooling panel according to Claim 1, [characterized in that] wherein the ribs thicken towards their free ends remote from the main body of the cooling panel.

13. (Amended) Shaft furnace provided with a jacket which on the inside is at least partially provided with cooling panels according [to one of Claims 1-12] Claim 1.

14. (Amended) Process for producing a cooling panel according to [one of Claims 2-13] Claim 2, [characterized in that] wherein the continuous tube (or tubes) is firstly given its final shape, after which the copper for the cooling-panel body to be formed is cast as cast material around [it] the tube at a temperature which is so close to the melting point of material of the tube [material] that, after the cast material has cooled, [it] the cast material is attached to the [tube] material of the tube.

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# COOLING PANEL FOR A SHAFT FURNACE, SHAFT FURNACE PROVIDED WITH COOLING PANELS OF THIS NATURE, AND A PROCESS FOR PRODUCING SUCH A COOLING PANEL

The invention relates firstly to a cooling panel for a shaft furnace of the type through which at least one vertical duct runs, the ends of which are connected to connection ends running transversely with respect to the plane of the cooling panel. The invention furthermore relates to a shaft furnace provided with a jacket, the jacket being provided on the inside with cooling panels of this nature. In this context, the jacket is understood to mean the metal casing of the furnace. Finally, the invention relates to a process for producing the novel cooling panels.

A standard embodiment of a shaft furnace is a blast furnace for the reduction of iron ore. However, shaft furnaces are frequently also used for other purposes. Where the following text explains the invention with reference to applications for a blast furnace, this description also comprises applications for other types of shaft furnaces.

The thermal loads imposed on the wall of a blast furnace are generally extremely high. These thermal loads may, for example, be of the order of magnitude of 250 000 $W/m^2$. To prevent damage to the metal casing of the furnace, it is therefore necessary to provide this wall with a cooling system. One of the means which is frequently employed for this purpose is the use of so-called cooling panels. These are metal panels which are attached to the inside of the steel casing, also known as jacket or steel jacket, at least one vertical duct running through these cooling panels. These ducts are then connected to connection ends which run through the jacket. That side of the cooling panel which faces towards the inside of the furnace may be provided with recesses in which refractory bricks are fitted, in order to avoid or at least reduce direct thermal contact between the hot furnace charge and the cooling panel. Unlined cooling panels are also used, however, in which case the cooling panel is cooled so intensively that a solidified crust is formed against them. This solidified crust consists of slag constituents and constituents of the charge inside the furnace.

Traditionally, cooling panels are made from cast iron. However, it has been found that cast iron panels can lead to problems if the refractory lining becomes worn or if parts of the crust break or melt off. Specifically, a sudden increase in the thermal load on the cooling panel, partially owing to structural changes in the material of the cooling panel, may give rise to deformation of the cooling panel and movements thereof which, especially if they are repeated a number of times, may lead to cracks and leaks in the water ducts. To some extent, leaks of this nature can be avoided by closing off ducts. If there are a number of leaks, it may be necessary to shut down the furnace and carry out emergency repairs.

Previously, it has been proposed to reduce these drawbacks by casting the cooling panels not from cast iron but from copper. Due to the better thermal conductivity of copper, such a panel can tolerate higher thermal loads, while temperature differences within the cooling panel are lower. Consequently, this also reduces the risk of leaks and cracking in the cooling panel. Nevertheless, it has been found that even with cast copper cooling panels problems may arise in the long term, inter alia as a result of fatigue phenomena in the material and owing to casting defects present in cast copper cooling panels. In US 4,382,585, it is proposed to eliminate these drawbacks by producing a cooling panel not by casting copper, but rather by machining a thick rolled or forged copper sheet. In this case, the ducts are drilled through this sheet and in some cases blocked again at the ends. This design has also proven to have drawbacks. Blocking the ends of the ducts may again lead to leakage. Also, the shape of such cooling panels is limited owing to the way in which they are produced. A profiled surface on the furnace side can only be achieved at high cost, while the drilling of long ducts limits the length of the cooling panels. Generally, one drawback of the known copper cooling panels is that the connection ends also consist of copper. In many cases, copper is too soft to make mechanical connections for the cooling panels.

Therefore, there is a need for a cooling panel which consists predominantly of copper and does not have the drawbacks described. Moreover, this cooling panel is to be of a form which reduces the thermal loads and allows a stable crust to form, providing additional protection and thermal insulation for the cooling panel.

It has been found that such a cooling panel according to the invention can be obtained if, in this cooling panel, each duct and the connection ends are formed from a continuous tube made from a material selected from the group consisting of low-carbon steel, stainless steel and an alloy which predominantly comprises Cu and Ni with an Ni content of $\geq 28\%$ by weight, and the remainder of the cooling panel consists of copper which is cast around this tube, the cooling panel being provided, on the side remote from the connection ends, with a multiplicity of horizontal ribs. Preferably the ribs have a length, in the width direction of the cooling panel which is smaller than the width of the cooling panel.

More preferably the ribs have a length in the said width direction of the cooling panel of $\leq 50\%$, preferably $\leq 25\%$ of the width of the cooling panel. The copper/nickel alloy as described has a higher melting point than copper, with the result that the copper body of the cooling panel can be cast around these tubes without the tube itself also melting. It has proven possible to form copper-nickel alloys with a high nickel content into high-quality tubes which are generally used for heat-exchanger pipes under exacting mechanical, thermal and chemical conditions. Even if the cast copper body begins to exhibit pores or cracks, there will still be no leakage of water owing to the

high quality of the tube used. By furthermore providing the cooling panel with ribs on the side facing towards the furnace content, spaces are formed between these ribs, in which spaces a crust can form. The crust can consist of slag, ore, iron or a mixture thereof. Also, the crust can have been prepared by applying refractory bricks, concrete or masses between the ribs. If the ribs taper, that means that the heat flux to the main body of the cooling panel is reduced, which is of benefit to the durability of the cooling panel. By positioning a plurality of ribs next to one another on the cooling panel and making them short, it is also possible to avoid high thermal stresses in these ribs, so that they themselves also have a longer service life.

However, according to the invention, the ribs may also be shaped such that they thicken towards their free ends remote from the main body of the cooling panel. This prevents the loosening of the crust from within the ribs, which guarantees an extra protection of the cooling panel.

It should be noted that US patent No. 3,853,309 has disclosed a water-cooled blowing nozzle in which a copper/nickel tube is also cast in copper over part of its length. However, the use of blowing nozzles in a blast furnace in technical terms relates to a completely different problem from that of cooling a furnace wall with the aid of cooling panels.

According to the invention, an alloy which contains between 65 and 70% by weight Ni, approx. 3% by weight Fe and $\leq 1\%$ of one or more of the elements Mn, Si and C has proven to be a particularly suitable material for the continuous tube according to the invention. The use of Monel, which has a composition of approx. 28% Cu, 68% Ni, 3% Fe, 1% Mn and low Si and/or C contents, is particularly preferred.

An important function of the ribs is that they allow a crust to form on the surface of the cooling panel, and in particular they are also able to hold this crust in place. The latter factor is also of undoubted importance in view of the fact that the charge which is moving continuously down the blast furnace exerts a high frictional force on the wall and thus, in particular, on the crust formed. Ultimately, a large part of this frictional force is absorbed by the ribs, which thereby run the risk of becoming damaged. To ensure that these ribs are well able to withstand this frictional force, it has proven highly advantageous, according to the invention, to provide these ribs with supporting backs. These supporting backs ensure that the vertical load imposed is better absorbed and distributed by the cooling panel. As a result, the risk of the ribs being deformed, breaking off or being damaged in some other way is reduced.

In a first embodiment of these ribs with a supporting back, each of the ribs with a supporting back is T-shaped in cross section, parallel to the plane of the cooling panel. According to another embodiment, each of the ribs with supporting backs has a cross section in the shape of a +, parallel to the plane of the cooling panel.

At locations where the frictional force of the falling charge may be extremely high, it may be advisable to provide the ribs with a plurality of supporting backs. According to one possible embodiment according to the invention, for this purpose the ribs are provided with supporting backs on either side in the vicinity of their ends.

Copper as a material for cooling panels is considerably more expensive than cast iron. However, owing to the much better thermal conductivity of copper than that of iron, it has proven possible to save considerable amounts of material through the shape of the cooling panel. In one possible embodiment of the cooling panel, for this purpose the wall is provided with undulating recesses on the side of the connection ends, on either side of each duct, in which recesses reinforcing walls which fill up the recesses are distributed over the height of the cooling panel. Despite the fact that the cooling panel has consequently been locally thinned, it remains sufficiently strong. Optionally in combination with these undulating recesses on the side of the connection ends, it has also proven possible, in another embodiment of the cooling panel according to the invention, to provide the wall on the side remote from the connection ends with undulating recesses on either side of each duct. This also allows considerable amounts of material to be saved.

In addition to the cooling panel described, the invention also relates to a shaft furnace provided with a jacket which on the inside is at least partially provided with the cooling panels described above.

Finally, the invention also relates to a process for producing a cooling panel of one of the types described above. This process is characterized in that the continuous tube (or tubes) is firstly given its final shape, after which the copper for the cooling-panel body to be formed is cast around it at a temperature which is so close to the melting point of the tube material that, after the cast material has cooled, it is attached to the tube material. This method results in there being virtually no resistance to the passage of heat between the continuous tube and the surrounding copper of the cooling panel. In this context, it should be noted that the term copper is to be understood as meaning not only completely pure copper but also low alloy copper with a composition such as that which is customarily used for the production of copper cooling panels.

The invention will now be explained with reference to a number of diagrammatic figures.

Fig. 1 shows a longitudinal section through a cooling panel.

Fig. 2 shows a detail of this panel on an enlarged scale.

Fig. 3 shows part of a cross section through the cooling panel shown in Fig. 1, on an enlarged scale.

Fig. 4 shows a perspective view illustrating the detail from Fig. 2.

Fig. 5 shows a possible configuration of ribs with supporting backs.

Fig. 6 shows smaller ribs in larger numbers.

Fig. 7 shows ribs with additional supporting backs.

Fig. 8 shows yet another configuration of the ribs with supporting backs.

In Figs. 1 and 3, (1) denotes the steel casing of a blast furnace (the so-called jacket). A cast copper cooling panel body is denoted by (2), through which a cast-in tube (3) runs. This tube is made from Monel. The connection ends (4) and (5) of the continuous tube (3) project through openings in the jacket (1), through which cooling water from outside the furnace can circulate through the cooling panel inside the furnace and thus cool this panel. As can be seen from Fig. 3, it is possible for a plurality of continuous tubes (3) to be cast into the cooling panel (2).

The space between the jacket (1) and the cooling panel may be filled up with a casting compound (6). Attachment bolts for attaching the cooling panel to the jacket (1) from outside the furnace are not shown. This attachment method is of a traditional nature, as is customarily used in cooling panels.

Tapering ribs (7) are cast onto the furnace side of the cooling panel. These ribs (7) may be distributed over the surface of the panel in a pattern such as that shown in Fig. 5. Since the length of these ribs is limited, it will be impossible for high thermal stresses to build up in these ribs. A vertical frictional force which a downwardly moving charge may exert on the ribs can be absorbed by supporting backs (9) (cf. Fig. 2 and Fig. 5).

Solidifying crust material (8) may collect between the ribs, and if appropriate the supporting backs, forming thermal insulation between the furnace content and the cooling panel. The shape of the ribs prevents the possibility of this crust being torn off again easily by the downwardly moving charge. Furthermore, the tapering form of the ribs limits a high thermal load on the cooling panel via the ribs. As the crust (8) becomes thicker, that part of the ribs which is exposed to heat will become smaller.

If, after prolonged use of the cooling panels and/or as a result of fluctuating thermal loads on these panels as a result of highly divergent operating conditions, the cooling panels should become damaged, this damage will be limited to small cracks (13) in the vicinity of the outer edge of the ribs, as indicated in Fig. 4. It has been found that damage of this nature remains limited and certainly will not propagate into the main body of the cooling panel. Even if damage were to arise in that area as a result of extreme operating conditions, this does not lead to damage to the cast-in Monel tubes.

Fig. 3 furthermore shows how it is possible to save copper during the construction of the cooling panels by making that wall (11) of the cooling panel which faces towards the jacket (1) undulate around the tubes (3). The strength of the cooling panel can be maintained by arranging reinforcing walls (12) in the recesses formed, distributed over the height of the cooling panel.

In a similar way, it is also possible to make that surface (10) of the cooling panel which faces towards the furnace content undulating.

The ribs (7) can be made larger or smaller depending on whether it is desired for them to penetrate more or less deeply into the furnace. Fig. 6 shows an embodiment in which smaller ribs (7) with supporting backs (9) are arranged in a more tightly packed pattern.

If working under conditions in which it is possible to expect extremely high frictional forces from a downwardly moving charge, it is recommended for each rib to be provided with a multiplicity of supporting backs. In the embodiment shown in Fig. 7, four supporting backs (15-18) are arranged on each rib (14). This shape provides an additional resistance to a crust (8) which has formed being torn off.

Fig. 8 shows yet another embodiment (20) of the ribs with supporting backs. These are in the form of upright crosses.

## CLAIMS

1. Cooling panel for a shaft furnace of the type through which at least one vertical duct runs, the ends of which are connected to connection ends running transversely with respect to the plane of the cooling panel, in which furthermore each duct and the connection ends are formed from a continuous tube made from a material selected from the group consisting of low-carbon steel, stainless steel and an alloy which predominantly comprises Cu and Ni with an Ni content of $\geq 28\%$ by weight, and the remainder of the cooling panel consists of copper which is cast around this tube, the cooling panel being provided, on the side remote from the connection ends, with a multiplicity of horizontal ribs.

2. Cooling panel according to Claim 1, characterized in that the material of the continuous tube contains between 65 and 70% by weight Ni, approx. 3% Fe and $\leq 1\%$ of one or more of the elements Mn, Si and C.

3. Cooling panel according to Claim 2, characterized in that the material of the continuous tube consists of Monel, with a composition of approx. 28% Cu, 68% Ni, 3% Fe, 1% Mn and low Si and/or C contents.

4. Cooling panel according to one of claims 1-3, characterized in that the ribs have a length, in the width direction of the cooling panel, which is smaller than the width of the cooling panel.

5. Cooling panel according to claim 4, characterized in that the ribs have a length in the width direction of the cooling panel of $\leq 50\%$, preferably $\leq 25\%$, of the width of the panel.

6. Cooling panel according to one of Claims 1-5, characterized in that the ribs are provided with supporting backs.

7. Cooling panel according to Claim 6, characterized in that each of the ribs with a supporting back is T-shaped in cross section, parallel to the plane of the cooling panel.

8. Cooling panel according to Claim 6, characterized in that each of the ribs with supporting backs are in the shape of a + in cross section, parallel to the plane of the cooling panel.

9. Cooling panel according to Claim 6, characterized in that the ribs are provided with supporting backs on either side in the vicinity of their ends.

10. Cooling panel according to one of Claims 1-9, characterized in that the wall is provided, on the side of the connection ends, on either side of each duct, with undulating recesses in which reinforcing walls which fill up these recesses are distributed over the height of the cooling panel.

11. Cooling panel according to one of Claims 1-10, characterized in that the wall, on the side remote from the connection ends, is provided, on either side of each duct, with undulating recesses.

12. Cooling panel according to Claim 1, characterized in that the ribs thicken towards their free ends remote from the main body of the cooling panel.

13. Shaft furnace provided with a jacket which on the inside is at least partially provided with cooling panels according to one of Claims 1-12.

14. Process for producing a cooling panel according to one of Claims 2-13, characterized in that the continuous tube (or tubes) is firstly given its final shape, after which the copper for the cooling-panel body to be formed is cast around it at a temperature which is so close to the melting point of the tube material that, after the cast material has cooled, it is attached to the tube material.

**PCT**

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# INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)


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**Published**
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**(54) Title:** COOLING PANEL FOR A SHAFT FURNACE, SHAFT FURNACE PROVIDED WITH COOLING PANELS OF THIS NATURE, AND A PROCESS FOR PRODUCING SUCH A COOLING PANEL

**(57) Abstract**


Cooling panel for a shaft furnace of the type through which at least one vertical duct runs, the ends of which are connected to connection ends running transversely with respect to the plane of teh cooling panel, in which furthermore each duct and the connection ends are formed from a continuous tube made from a material selected from the group consisting of low-carbon steel, stainless steel and an alloy which predominantly copmrises Cu and Ni with an Ni content of ≥ 28 % by weight, and the remainder of the cooling panel consists of copper which is cast around this tube, the cooling panel being provided, on the side remote from the connection ends, with a multiplicity of horizontal ribs.


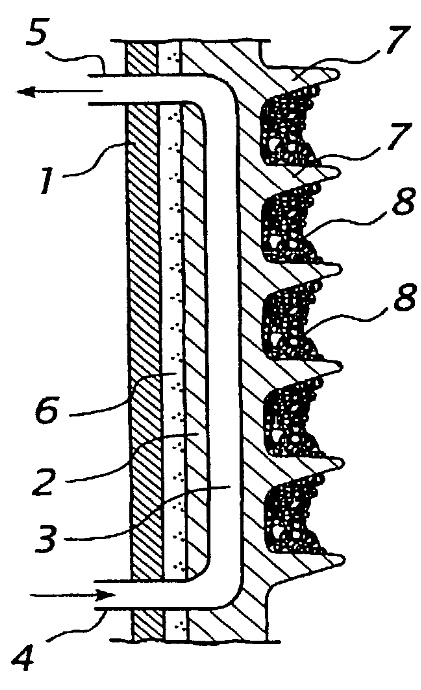

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Fig. 1

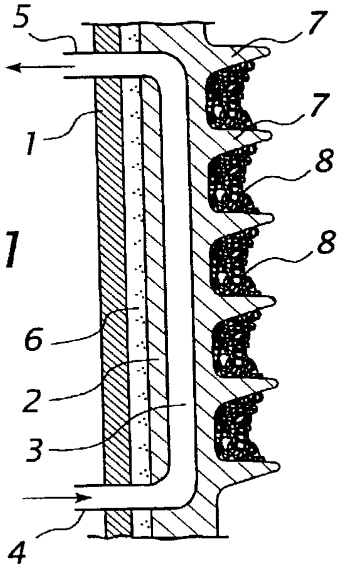



Fig. 2

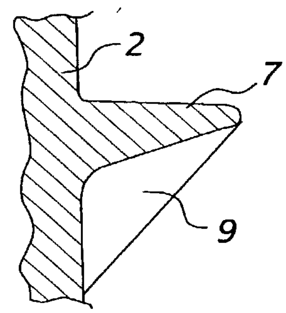



Fig. 3

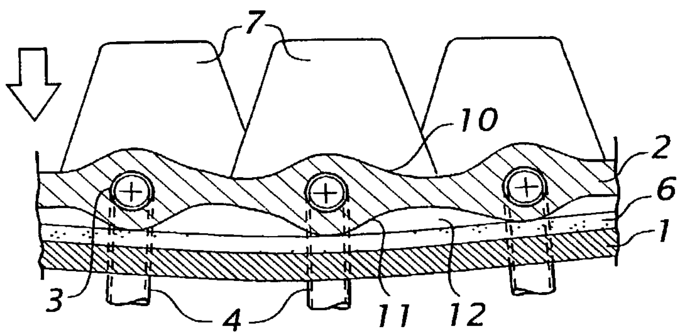



Fig. 4

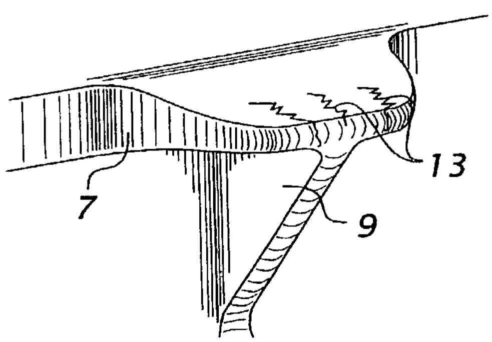


Fig. 5

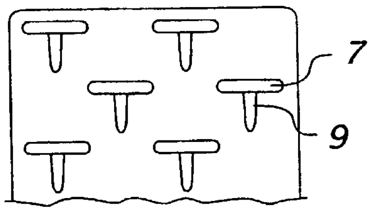



Fig. 6

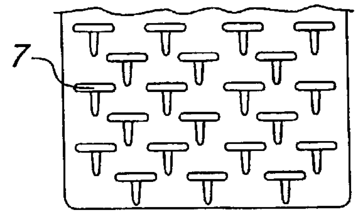



Fig. 7

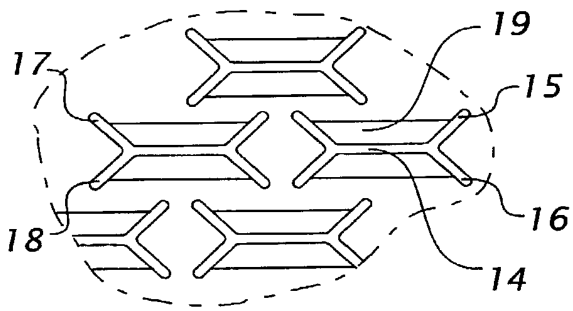
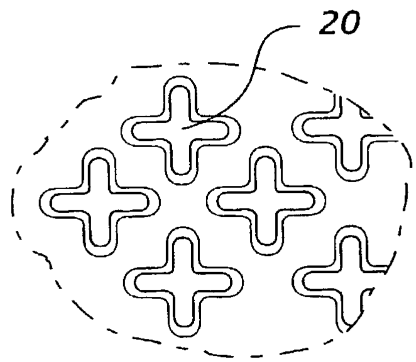



Fig. 8



| COMBINED DECLARATION AND POWER OF ATTORNEY FOR UTILITY PATENT APPLICATION (Includes PCT) | Attorney Docket No. APV31549 |
|---|---|

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; that

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural inventors are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

COOLING PANEL FOR A SHAFT FURNACE, SHAFT FURNACE PROVIDED WITH COOLING PANELS OF THIS NATURE, AND A PROCESS FOR PRODUCING SUCH A COOLING PANEL

the specification of which (check one)

[ ] is attached hereto.

[ ] was filed on ______________ as Application Serial No. ______________ and was amended on ______________. (if applicable)

[X] was filed as PCT International Application No. PCT/EP00/03505, on April 13, 2000, and was filed in the U.S. National Stage on March 12, 2002 as U.S. Patent Application No. (Not Available).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I do not know and do not believe the claimed invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application.

I hereby claim foreign priority benefits under Title 35, United States Code §119 and/or §365(a)(b) of any foreign application(s) and United States provisional applications for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application(s) on which priority is claimed:

| Prior Foreign and U.S. Provisional Application(s) | | | Priority Claimed | |
|---|---|---|---|---|
| 1011838 (Number) | NL (Country) | 20 April 1999 Day/Month/Year Filed | [X] Yes | [ ] No |
| ______ (Number) | ______ (Country) | ______ Day/Month/Year Filed | [ ] Yes | [ ] No |

I hereby claim the benefit under Title 35, United States Code, §120 and/or §365(c) of any United States application(s) or PCT international application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Attorney Docket No.

| Application Serial No. | Filing Date | Status (patented, pending, abandoned) |
| --- | --- | --- |
| Application Serial No. | Filing Date | Status (patented, pending, abandoned) |

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith; Stevens, Davis, Miller & Mosher, L.L.P.; Anthony P. Venturino, Reg. No. 31,674; James E. Ledbetter, Reg. No. 28,732; and Thomas P. Pavelko, Reg. No. 31,689, Peter N. Lalos, Reg. No. 19,789. Direct all telephone calls to telephone no. 202-785-0100 and faxes to 202-408-5200.

Address all correspondence to 1615 L Street, N.W., Suite 850, Washington, D.C. 20036.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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